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Estimation of Numbers for a Riverine *Necturus* Population Before and After TFM Lampricide Exposure

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Abstract

The purpose of this research was to assess the impact of the lampricide, 3-trifluormethyl-4-nitrophenol, upon the mudpuppy, *Necturus maculosus*, in the Grand River, Lake County, Ohio. Pre-treatment and entire season population estimates for 1987 and 1988 were made using Schnabel estimation. Population estimates ranged from 556–1,118 per km in 1987 but declined to 280–397 per km in 1988. Comparison of pre-treatment or entire season estimates between years indicates a minimum 29% decrease in population size. Individuals within the range of total lengths examined appear to exhibit equal sensitivity to TFM. Intensive seining and manual turning of rock slabs were effective methods for capturing *Necturus*; trapping and electroshocking proved ineffective.

Introduction

The lampricide 3-trifluoromethyl-4-nitrophenol (TFM) has been used in control of sea lamprey in the Great Lakes drainage since 1958 (National Research Council of Canada, 1985). The chemical has been found toxic to a number of vertebrate taxa, and the degree of toxicity is dependent upon application concentration, temperature, pH and hardness of the water. Relatively little field research has been published concerning effects of TFM on amphibians even though field treatment summaries frequently refer to mortality of amphibians. Gilderhus and Johnson (1980) note mortality in anuran tadpoles in 16% of treatment summaries; mortality in *Necturus* was noted in 32% of observations from Lake Superior tributaries, 36%

from Lake Michigan tributaries, and of those observations 18% referenced high mortality.

In October 1986, TFM was applied to Conneaut Creek located in Ashtabula County, Ohio and Crawford County, Pennsylvania. Mortality in *Necturus* was high, but no population data were available either before or after the TFM application. The Grand River in Lake and Ashtabula Counties of Ohio was scheduled to receive TFM treatment during spring of 1987. To assess the impact of the lampricide upon the population of *Necturus maculosus*, pre-treatment and post-treatment population estimates were made and then compared. For additional comparative purposes, the study was continued during 1989, and statistical comparison of population estimates was made between years.

Study Area and Methods

Field work extended from March through July 1987 and from April through July 1988. High water, shortage of time, and difficulty in capturing animals limited the number of sites where the population was studied to one. The 600 m study site was located in the Grand River, Madison Twp., Lake County, Ohio (Thompson, Ohio 7.5 min. topographic map, 1960, photorevised 1970). Two meanders, one riffle, three gravel bars, and several pools were major channel features. Pools present were of three types: isolated, flood-plain pools (IFPP); rapid-bounded pools (RBP); and sequential, incised channel-margin pools (SICMP). Water depth ranged from 10 cm to approximately 2 m during the summer months but was subject to dramatic fluctuations from low water under drought conditions during summer, 1988, to spring flood stage in early March or April. Substrate in the river channel consisted of sand, gravel, cobbles, large glacial erratics, and slabs of siltstone from the Chagrin Shale, some of which exceeded two meters in length. Pools had substrates of sand, silt and large boulders or siltstone slabs, whereas others collected detritus and silt to a depth of 10–15 cm.

Four methods were used to capture *Necturus* during 1987: intensive seining with 3.7 m and 7.6 m bag seines, manual overturning of rock slabs capturing animals in a 1.8 m seine, trapping with baited minnow-like traps, and electroshocking using both back-pack and small pull-behind units. Intense seining was productive from late March to early May and consisted of seining SICMP and RBP repeatedly with assistants churning the substrate before the net. This produced chocolate-colored water with much floating and suspended organic material. Overturning slabs was productive from mid-May through July when

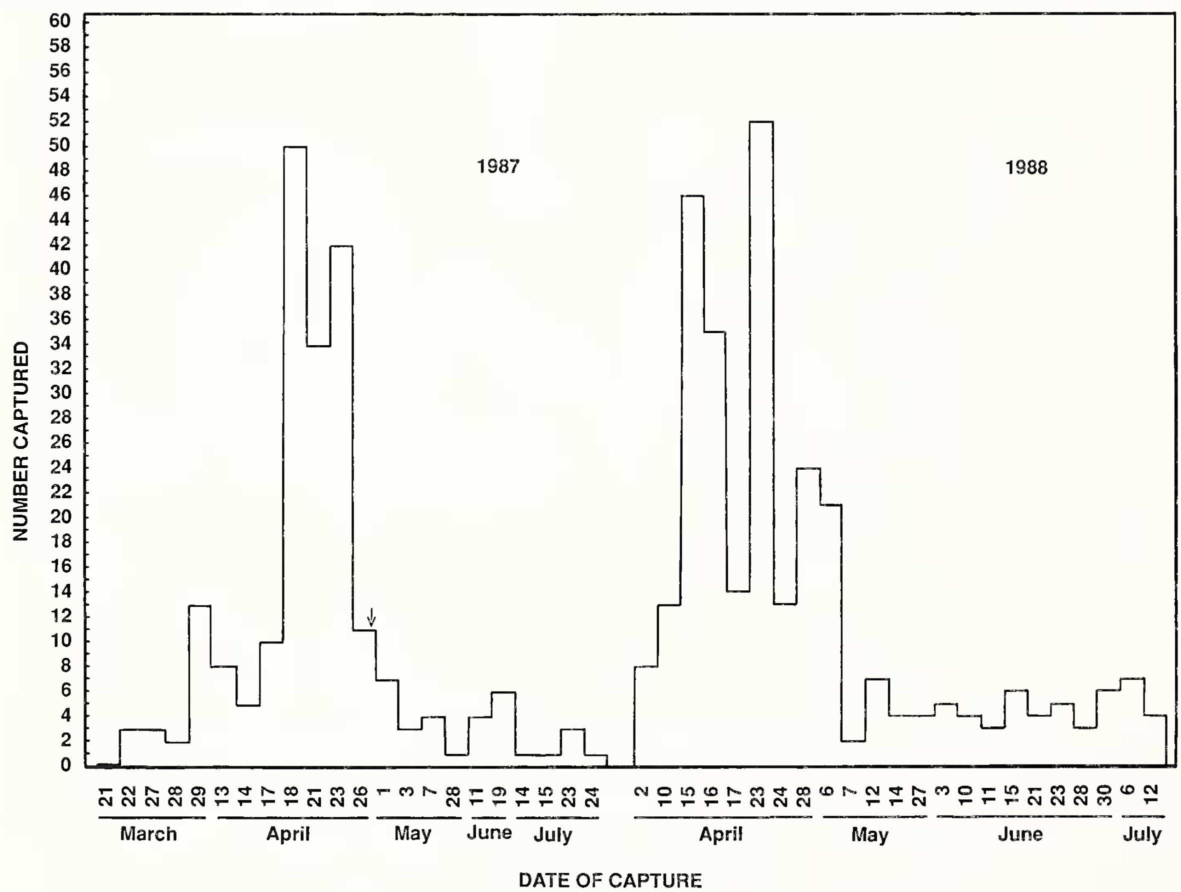

FIGURE 1. *Histogram of the number of* Necturus maculosus *captured on different dates during 1987 and 1988. Exposure to TFM occurred on 27 April 1987 and is indicated by the arrow.*

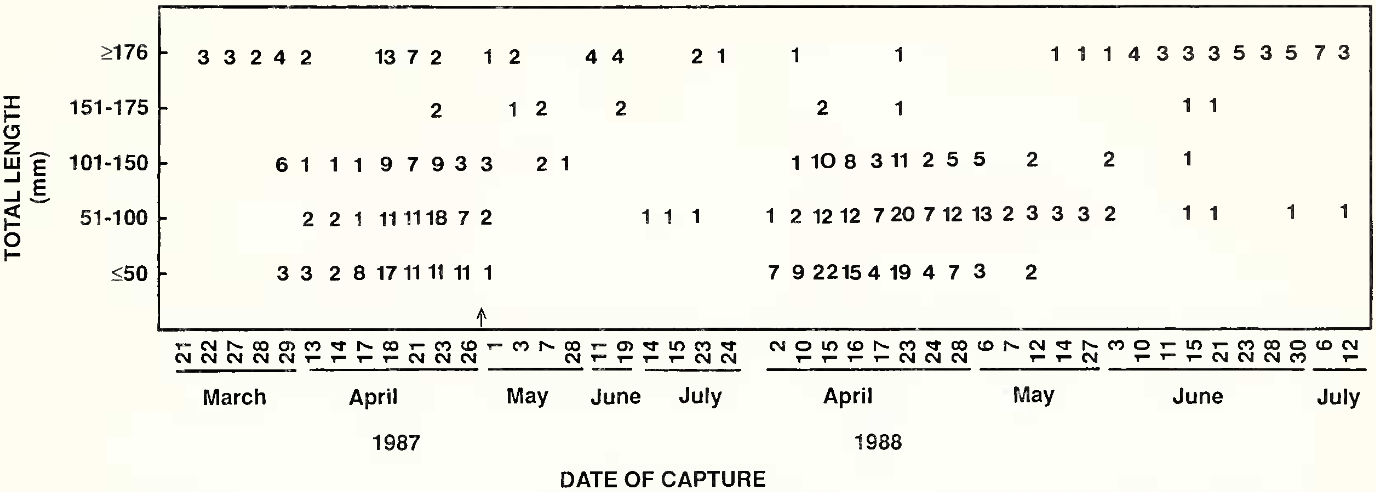

FIGURE 2. *Number of* Necturus maculosus *within size cohorts captured on different dates during 1987 and 1988. Exposure to TFM occurred on 27 April 1987 and is indicated by the arrow.*

water depth was reduced. Trapping and electroshocking were unsuccessful for capturing *Necturus*. Trapping produced only 1 capture in 126 trap nights, and electroshocking was totally ineffective. Seining and slab turning were the only methods used in 1988.

All animals captured were marked by toe-clipping. Individuals marked in the pre-treatment phase during 1987 were marked by removing the outermost toe on the left hind foot; individuals captured during the post-treatment phase of the study were marked in similar fashion on the right. All animals were toe clipped on the left front foot in 1988. The Schnabel method of population censusing and estimation was used to estimate population size before and after treatment of the river with TFM. Chapman's Poisson table was used to calculate 95% confidence interval estimates for ≤50 recaptures. The standard normal approximation to the Poisson was used to estimate 95% confidence intervals for >50 recaptures (Seber, 1973). Population estimates were compared using the normal approximation z-statistic (Seber, 1973). Null hypotheses tested were: 1) There was no difference in population size between pre-treatment and post-treatment estimates during 1987; 2) There was no difference in population size between intervals corresponding to the pre-treatment period between years; 3) There was no difference in population size for entire data sets between years.

Total length (TL) of each animal was measured to the nearest millimeter (mm) in the field to examine differential mortality associated with size and to compare catchability using various methods.

The site was searched for dead *Necturus* during and following TFM exposure on 27 and 28 April.

Results

Intensive seining yielded the greatest number of captures and detected most small larvae and juveniles. Seining accounted for 181 of 212 (85.4%) animals examined in the field in 1987 and for 244 of 290 (84.1%) captures in 1988. Overturning rock slabs resulted in capture of 77 animals (15.3%). All but four animals captured using this technique had minimum TL of 150 mm.

Few animals were obtained from 21 to 29 March. Number of captures increased in early April, peaked during mid-month, and then decreased to fluctuate about mid-March levels through July (Figure 1). Captures of various size classes of *Necturus* were not evenly distributed temporally (Figure 2). No juveniles or small larvae were obtained before 29 March due at least in part to technique and high water, and only 51 animals with TL≤150 mm were captured after 1 May. Most animals captured between 29 March and 6 May were <150 mm TL and accounted for the elevated number of captures during this period (Figs. 1, 2). TFM treatment was initiated upstream of the site on 26 April and reached the site early morning on 27 April. Repeated searching of the site on the 27th and 28th of April for dead *Necturus* yielded six individuals of which three were marked. One individual was an adult in excess of 175 mm TL, while the remaining five were under 75 mm TL.

One hundred eighty-one (181) *Necturus* were captured during the pre-treatment phase of the study in 1987, and 31 individuals were obtained during the post-treatment phase. Population estimates and 95% confidence interval estimates are presented in Table 1. The comparison of pre-treatment with post-treatment population estimates for 1987 was invalid because only two *Necturus* were recaptured during the post-treatment phase having only the post-treatment

Table 1. Data obtained during two years of study of the Grand River *Necturus* Population. Comparisons of population estimates between years for both the pre-treatment and the entire season were significantly different (P<0.001).

	Number examined	Number Marked	Number Recaptured	Population Estimate(N)	95% C.I.E.
Pre-treatment					
1987	178	153	25	805/km	513, 1188/km
1988	205	120	85	262/km	212, 323/km
Entire Season					
1987	209	171*	35	803/km	556, 1118/km
1988	290	165	125	333/km	280, 397/km

* 3 marked animals found dead after TFM treatment

mark. Comparison of pre-treatment population estimates between years was statistically significant (P<0.001), as was the entire season estimate (P<0.001) between years.

Discussion

Cagle (1954) found baited nets, dip nets, seines and trotlines to be ineffective in capturing *Necturus maculosus louisianensis* in Louisiana. Setlines produced satisfactory catches of adults, and intensive dip netting and seining produced larvae. Shoop (1965) reported traps constructed of 6 mm wire mesh unsuccessful in capturing *Necturus maculosus louisianensis* and *N. beyeri*. However, unusually high success was achieved using baited setlines. Although no direct indication of success was stated, dip netting and seining were used by Shoop (1965) for capturing *Necturus* in Louisiana. Results reported here show that intensive seining produced the greatest number of captures and almost all animals <75 mm TL. Neither setlines nor trotlines were used in this study as both techniques would yield a bias toward large juveniles and adults and would result in a serious underestimate of population size and in increased mortality because *Necturus* tends to swallow baited hooks.

Shoop (1965) used electroshocking with some success to capture *Necturus* in excess of 140 mm snout-vent length in Big Creek, Louisiana. Eleven of 50 individuals were obtained by electroshoeking; the remaining individuals being taken on baited set lines. No indication of time, effort required or success rate was stated. Fitch (1959) was successful in collecting 28 *Necturus* with the aid of an electroshocker in April at Sugarloaf Lake, Michigan. My results contrast with those in Louisiana and Michigan in that electroshocking was found totally ineffective. Employment of the technique under different water conditions in the Grand River or where animals are not concealed beneath slabs may produce some catches, but it seems improbable that the method is useful for capturing many individuals as is required for population estimates. This assertion is supported by the observation that after using an electroshocker in a SICMP with no *Necturus* apparent, the pool was intensively seined and 13 individuals, small larvae, juveniles and adults, were captured.

The dramatic increase in number of *Necturus* caught from late March through the end of April is difficult to explain. Bishop (1926) mentioned movements or migrations in streams and lakes, and vernal movements from lakes into streams were noted by Pope (1962). Movements into lake shallows during April and May were reported by Fitch (1959) and by Gibbons and Nelson (1968); adult *Necturus* were reported to retreat to deeper, eolder waters in summer, while larvae remained in shallower, warmer waters (Harris, 1958). Movement into shallows does not appear to be the factor involved at this site in the Grand River. On the contrary, nearly all *Necturus* were obtained during March, April, and early May in SICMP where water depth was greater than in the main river channel.

Field technique improved over time during March, 1987, and poor technique may partially explain the low number of captures early in the study. High water in early spring hampered activities in the river in both years and contributed to the low number of captures. However, the same seining techniques which produced high catches in April were less successful from late April through July in the same pools. Furthermore, the capture pattern in 1988 is nearly identical to that of 1987. Small larvae and juvenile classes that were common in SICMP collections from late March through late April or early May were absent thereafter. Movement from pools into the channel may explain these observations. Consequently, for population size estimates or age-size population studies this procedure produces a biased estimate against large juveniles and adults; whereas slab turning produces a bias against larvae and juvenile classes.

Inspection of the data from 1987 with respect to the size and number of individuals captured over time suggested that *Necturus* ≤150 mm TL may have suffered higher mortality than larger animals (Figure 2). This hypothesis was formulated on the observation that after 1 May 1987 few animals ≤150 mm TL were captured. If this hypothesis was correct, then proportionately fewer animals within this size cohort would have been expected to appear in the 1988 capture data. On the contrary, more *Necturus* within this cohort were captured in 1988; apparently differential mortality did not occur. The total number of *Necturus* examined in 1988 was higher than that in 1987 (Table 1); improved capture techniques and reduction of water flow and depth resulting from drought are probable causes for higher capture in 1988.

My data do not agree with those derived from caged *Necturus* experiments in the Grand River (Daugherty and Klar, 1988) where observed mortality was restricted to individuals with TL <50 mm. The experimental procedure is not explicitly described by Daugherty and Klar, and it is not stated if individuals of different size classes were placed into a single cage or were placed by similarity of size into separate cages. Furthermore, it is unclear how mortality was observed, i.e. if the animals were found dead or if some were injured or disappeared, perhaps due to cannibalism. They suggest overcrowding in cages as possible cause for observed mortality. This is unlikely for the day or two the animals were confined unless cages were very small and crowding was intense resulting in physical interaction or injury (personal observation). It is possible that mortality observed in caged experiments did reflect increased susceptibility to TFM by small *Necturus* and that small individuals in pools where much of my data were obtained were able to escape some of the TFM effects by burrowing into the substrate.

Both pre-treatment and entire season comparisons between years indicate large reduction in population size from 1987 to 1988 following exposure to TFM within the treatment range of 2.1 mg/l to 6.6 mg/l (U.S. Fish and Wildlife chemical treatment summary). The 29% reduction in population size hinges in part upon accuracy of population estimates and was based upon the percentage decrease between the lowest 95% confidence interval estimate for the entire year of 1987 (556) and the upper estimate for 1988 (397). Schnabel estimates may reflect only the general order of magnitude of population size (Schnabel, 1938) and are dependent upon validity of certain assumptions (Seber, 1973; Caughley, 1977). Recruitment from reproduction was not a factor since no hatchlings, which are readily identifiable, were included in the estimates. Immigration and emigration may be factors that effect the population estimates; I am currently investigating these aspects of *Necturus* biology. Assuming immigration and emigration rates are equal and remain similar between years, they likely have negligible impact on the comparison of population size between years. The assumptions of random sampling and equal catchability of marked and unmarked individuals probably are valid. Toe clipping temporarily marks *Necturus*; however, clipped animals were readily identifiable as marked animals within the few months following marking. Therefore, loss of marks was not considered to effect estimates. Consequently, based upon two years of study, population size and degree of population reduction can only be approximated. Because mortality of *Necturus* during the TFM treatment was apparent (personal observation; U.S. Fish and Wildlife chemical treatment collection summary, 1987), notable decrease in population size can, at least in part, be attributed to the lampricide.

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